

CRANE WHEELS PRODUCTION QUALITY CONTROL

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Abstract: Quality control of crane wheels is an important part for support of crane mechanisms permanent operation. Normal functioning of logistics systems requires preventing of crane downtimes and delays. The research results of the impact of the crane wheels (710 mm diameter, 65Г steel) surface hardness on coercivity indicators are presented in this paper. Obtained research results of dependence between the coercivity indicators and the crane wheels rolling surface hardness for their use in practice are described. The influence of the crane wheels surface hardness on the coercivity indicators is researched. Research has shown the dependence of the coercive force from the regulatory crane wheels rolling surface hardness, which is received after a quenching. This research allows you to use obtained results for a quality control of the crane wheels quenching in the production process, a rapid control of the crane wheels at the expert examination.

Keywords: crane wheels, rolling surface hardness, coercivity, quality control

1. Problem setting

Crane wheels are an integral part of the crane mechanism, which in its turn is an important component in the chain of logistics operations in transport and warehouse logistics. Any repair works entail downtimes and delays of the logistic chain. Disturbed interaction between the links of the logistics chain is considered. To avoid failure of the crane wheels, it needs to conduct quality control of the production stage and at the express control. The replacement of the failed crane wheel can take some days. The replacement causes quality decreasing, the appearances of downtimes in logistic operations and increase in expenses.

Crane wheels thermal treatment is an integral part of their production. It is known that during steel quenching formed martensite. Martensite has a much larger volume as compared to the austenite and troostite This inevitably leads to internal stresses. Therefore, there is inevitable appearance of significant residual stresses in the formation of cast billets and subsequent thermal treatment (due to sudden changes in temperature) with a diameter of wheels castings more than 300-400 mm. Also, a significant overstating in the regulations [1] requirements for rolling surface hardness and flange cast wheels (up to 380-390 HB) results already in the process of production to the spontaneous destruction of wheels (during mechanical processing, and even at the warehousing).

2. Recent research analysis

There are researches of dependence between the crane wheels rolling surface hardness and the coercivity indicators on the surface [2-4]. It is found that the coercive force of no thermal treatment wheels of 55Ж steel is within 3-4 A/cm. The coercive force will be 5

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A/cm, and the hardness will be 298-313 HB at the same wheels after a heat treatment. The coercivity value is on average 6 A/cm in the finished wheels of 65Г steel. Also, the magnetic method of nondestructive control (NC) based on the coercivity may carry out the quality control of landing wheels on a shaft by the coercivity measuring before and after an assemblage. The difference of indicated value will be clear indicator of residual stresses.

More detailed studies of the use of magnetic coercive control to assess the quality of crane wheels quenching we have not found.

3. Unsolved aspects of the general problem

There is not shown dependence between the coercivity indicators and the wheels hardness in a form of a graph or a function in articles [2-4]. Also, from the content of the articles is unknown what diameter of crane wheels were studied. This greatly complicates the use of research in practice.

4. Objective of the article

To obtain research results of dependence between the coercivity indicators and the crane wheels rolling surface hardness for their use in practice.

5. Research results

The influence of the crane wheels surface hardness on the coercivity indicators [5] (Figure 1) are researched. We investigated the finished products after receiving from the control department (65Г steel, 710 mm wheel diameter). Measurements were carried out by KPM-ІІК-2M structuroscopes (head number 542, 834) and ТДМ-1 hardness tester (head number 469). Research was a continuation of [2-4] works.

Crane wheels, which were subject to control, were made in accordance with GOST 28648-90 [1]. The crane wheels of 65Г steel rolling surface hardness should be in the range 320÷390 HB. The depth of the quenching for the crane wheels with 710 mm diameter is not less than 25 mm. Magnetization depth of KPM-ІІК-2M structuroscopes according to [6] is much greater than 25 mm, which allows you to control the crane wheels after the quenching.

Measurement points of the hardness and the coercivity on the wheels overlap. At each wheel on the rolling surface was carried out by four measurements (Figure 2).

The results of our study are shown in Figure 3. Having approximation of the results we have received curve, which can be described by an exponential function (1). The resulting approximation is sufficient credibility ($R^2 = 0,9319$).

$$H_c(\text{HB}) = 1,2064 \cdot e^{0,0046 \cdot \text{HB}}. \quad (1)$$



Figure 1. Carrying out the magnetic method of nondestructive control (NC) on crane wheels

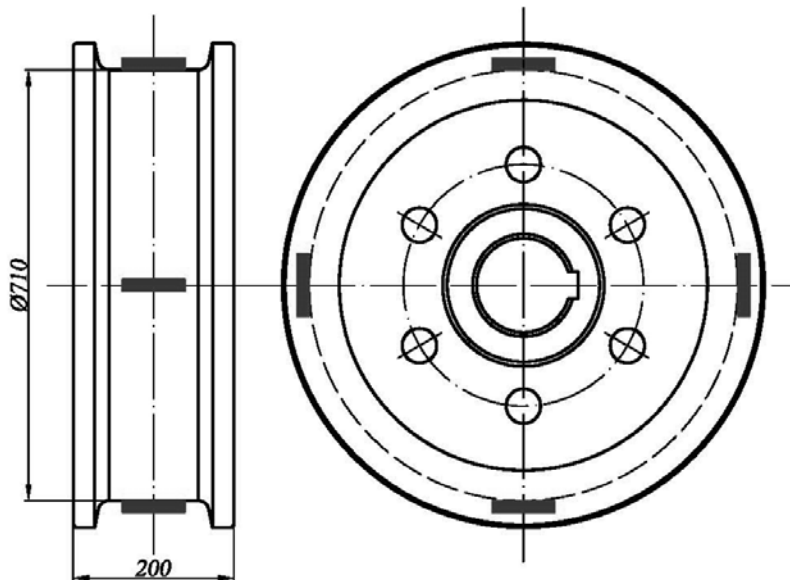


Figure 2. Measurement points of the hardness and the coercivity on crane wheels (■ – sensor of the hardness tester and the structuroscope)

Wheels were detecting during the research:

- no thermal treatment ("raw") - hardness 201-212 HB, 2,8-3,1 A/cm coercivity;
- insufficient hardness ("unquenching") - with 239-314 HB hardness, 3,6-5,3 A/cm coercivity;
- one wheel with high hardness ("requenching") - with 410 HB hardness and 8.3 A/cm coercivity.

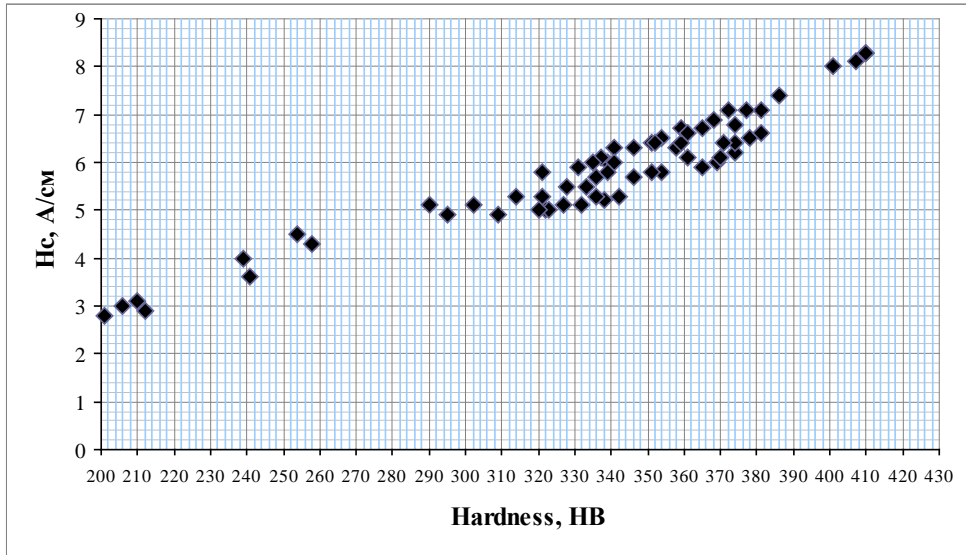


Figure 3. Results of the coercivity and hardness indicators on the crane wheels rolling surface (65Г steel, diameter 710 mm)

In the latter case the flaw appeared on the flange after a while (400-500 mm length (Figure 4).

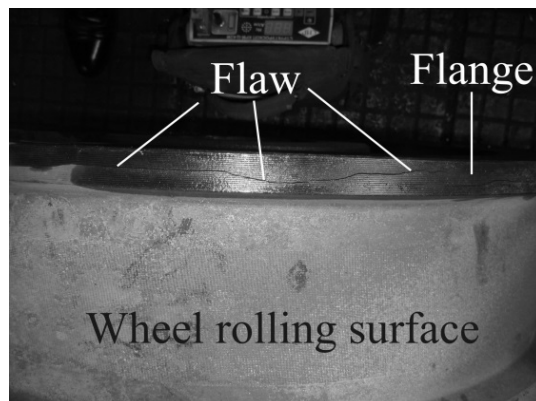


Figure 4. Defect is the flaw in the crane wheel flange due to the "requenching "

Normative base on magnetic coercive control in Ukraine and Russia has significant shortcomings that affect the objectivity and accuracy of the findings in the assessment of crane wheels.

Works on the magnetic method of nondestructive control, that solve existing problems, grounded and passed verification by practice. It needs necessary regulatory legalization. This will give the opportunity to conduct a magnetic coercive method for crane wheels with different thicknesses of elements to take into account the individual characteristics of the KPM-IIK-2M type magnetic structurescope, take into account the growth of the coercive force as a function of the intensity of metal loading.

To automate the process of analyzing the results of the magnetic coercive control, there is up to the calculation of residual life [7, 8].

And most importantly, there can not be limited in the assessment of metal with only one method. For a more objective result it should be applied magnetic coercive control in combination with other methods of control and calculation methods (finite element method, the limit states, the accumulated damage).

6. Conclusions

Researches have revealed that the regulatory crane wheels rolling surface hardness of 65Г steel with 710 mm diameter, which received after quenching, corresponds the coercivity ($320 \text{ HB} \approx 5,4 \text{ A/cm}$, $\text{HB } 390 \approx 7,4 \text{ A/cm}$). This allows you to use research results for the quality control of the crane wheels quenching in the production process, a rapid control of the crane wheels at the expert examination.

Quality control of crane wheels is an important part for support of crane mechanisms permanent operation. Normal functioning of logistics systems requires preventing of crane downtimes and delays. To avoid failure of the crane wheels, it needs to conduct quality control of the production stage and at the express control.

In the future, it is necessary to carry out the crane wheels research for other diameters and materials. To spread the quality control of the crane wheels manufacturing by using the coercivity. For a more objective result it should be applied magnetic coercive control in combination with other methods of control and calculation methods.

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